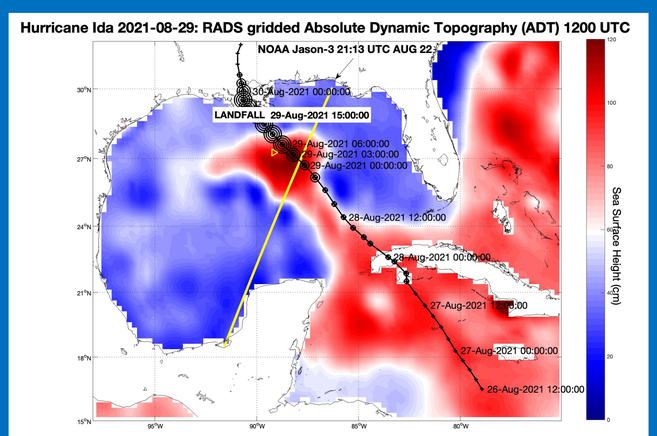
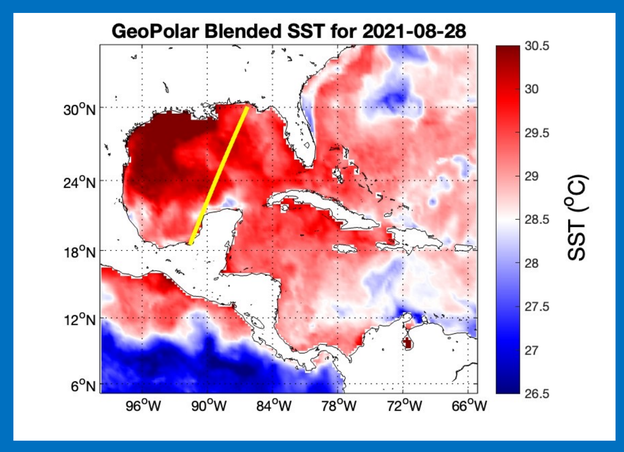
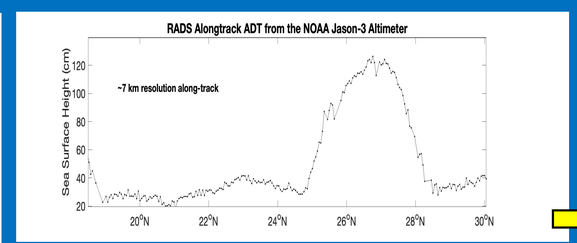
The NOAA Next-Generation Ocean Heat Content can provide **additional information** that may help predict rapid intensification of hurricanes.

INPUT







The Next-Generation Ocean Heat Content (NGE OHC) algorithm, using the 1 Hz along-track RADS ADT from Jason-3 and GeoPolar Blended 5km SST as input, accurately models a deep pool of water warmer than 26°C in the Gulf of Mexico, with temperatures above 30°C extending over 40 m in depth. The NGE OHC algorithm captures these extreme conditions with fidelity, showing significant improvement over the current NESDIS operational Ocean Heat Content product.

OUTPUT

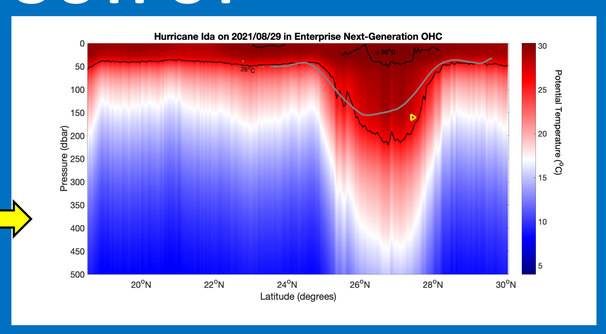


FIGURE KEY:
- Depth of 26°C isotherm measured by Argo float
- Depth of 26°C isotherm from NGE OHC
- Depth of 26°C isotherm from NESDIS op. product

OSTST APO2023_002

Assessing Tropical Cyclone Intensity Forecasts Using the NOAA Next-Generation Enterprise Ocean Heat Content Algorithm

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INTRODUCTION

- NOAA's Next-Generation Enterprise Ocean Heat Content (NGE OHC) is designed to help evaluate and improve forecasts of tropical cyclone intensification.

DATA SOURCES

- For the NGE OHC: World Ocean Database (WOD) temperature and salinity profiles (*T(z),S(z)*); Radar Altimeter Database System (RADS) along-track and gridded absolute dynamic topography (ADT); NOAA's (5 km) Geo-Polar Blended Global Sea Surface Temperature (SST) Analysis Level 4.

METHODS

- For the NGE OHC: *T(z)* and *S(z)* are parameterized in a 3-step process. First, at every depth as a function of dynamic height (φ). Next, the residuals of those fields are parameterized with respect to yearday, and finally the remaining residuals are parameterized as a function of SST.
- For the model: Profiles were taken from initializations of the Hurricane Analysis Forecast System-B v1.0 (HAFS-B). Output is provided for two forecasts for Gulf of Mexico hurricanes. These cases feature realistic cyclone tracks, but predictions of intensity were less accurate than desirable.

RESULTS

- Overall, the empirical NGE OHC parameterization shows good fidelity to observations. In 13 case studies involving 10 named storms and 98 proximate Argo profiles, the Tropical Cyclone Heat Potential (TCHP) estimated by the NGE OHC algorithm was consistently more accurate than that of HAFS. The increased accuracy was more pronounced as the TCHP increased. Overall, HAFS estimates were biased 3.8 kJ cm $^{-2}$ low, with the bias rising to 9.9 kJ cm $^{-2}$ over 60 kJ cm $^{-2}$, and to 19.2 kJ cm $^{-2}$ over 100 kJ cm $^{-2}$. NGE OHC biases for these ranges were 3.2 kJ cm $^{-2}$, 7.6 kJ cm $^{-2}$, and 16.5 kJ cm $^{-2}$, respectively.

FUTURE DIRECTIONS

- Now under development for the entire North Atlantic Ocean, the NGE OHC incorporates clustering to accommodate parameterizations of multiple different stratification regimes, and Sea Surface Salinity as an additional input. This algorithm should be able to provide ocean initial conditions of increased accuracy across the basin, potentially improving TC intensity forecasts.

How does the NGE OHC work?

Uses the *BLT method!*

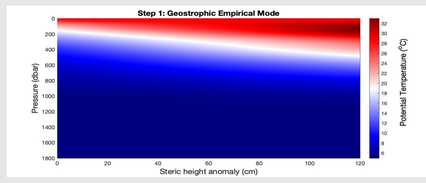
Byrne
Lavin
Trossman

A Geostrophic Empirical Mode (GEM)-based method

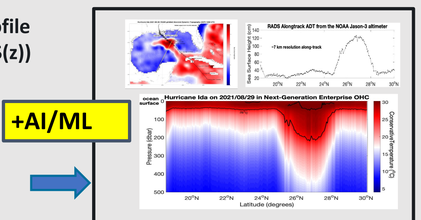
to derive look-up tables of SSH vs. T(z), S(z)

Database of *in situ* ocean profiles

1) Calculate steric height anomaly (SHA) for each profile
2) Use GEM to generate look-up table (SHA vs. T(z), S(z))



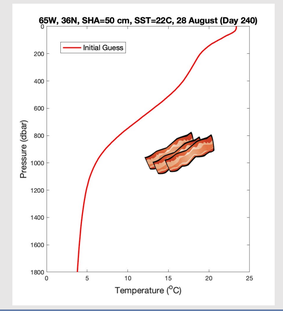
+AI/ML



Result = Lookup table where every satellite-measured ADT value in the region has a corresponding T(z) and S(z) profile

Coincident altimeter data (Absolute Dynamic Topography) from RADS

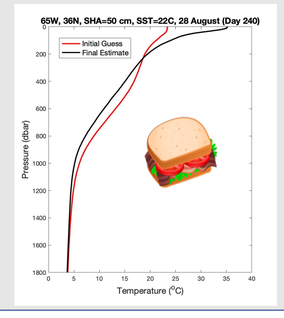
Calculate (typically linear) fit between the satellite-measured ADT and *in situ* steric height anomaly: m*ADT + b = SHA



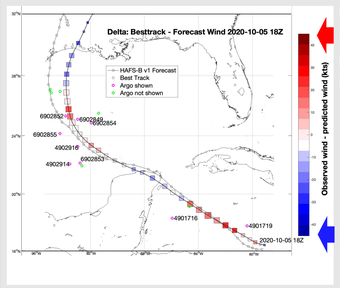
NB: GEM alone does not capture the full temperature and salinity variability, particularly in the mixed layer – Fit residuals!

(our easy to swap toppings)

Current toppings: Latitude, yearday, & SST



CASE STUDY 1: Hurricane Delta 2020-10-05 18Z prediction

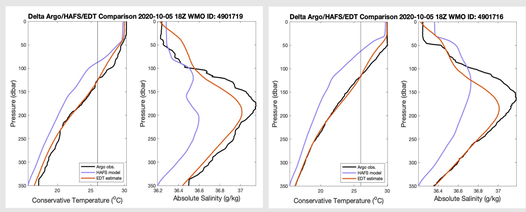


model has under-predicted intensity

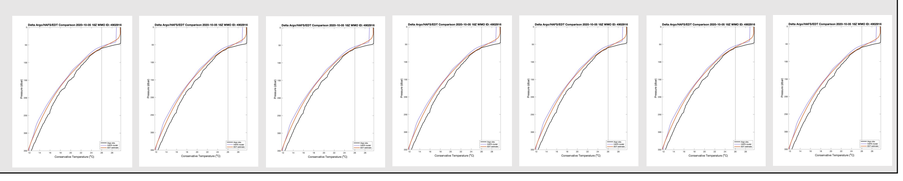
Size of squares □ indicates observed TC intensity

model has over-predicted intensity

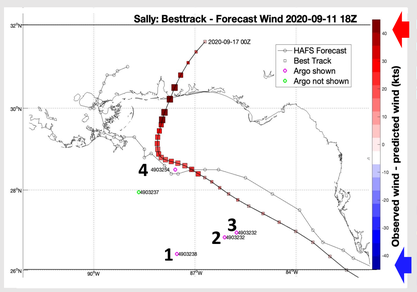
1. BEFORE FIRST LANDFALL (2 floats): The HAFS-B mixed layer is too cold, the near-surface salinity is too high, and the subsurface salinity maximum at ~175 dbar is strongly attenuated. All of these factors would contribute to an under-prediction of intensity.



2. BEFORE SECOND LANDFALL (7 floats): In the profiles examined, the HAFS-B surface isothermal layer is consistently too cold (0.7°C), while the NGE OHC mixed layer temperature is within 0.1°C of observed values from Argo floats.



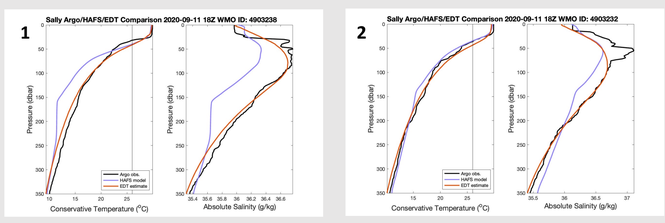
CASE STUDY 2: Hurricane Sally 2020-09-11 18Z prediction



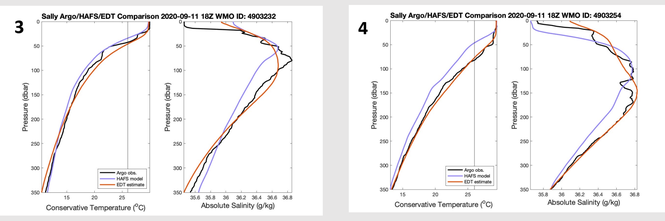
model has under-predicted intensity

Size of squares □ indicates observed TC intensity

model has over-predicted intensity



The combination of an unrealistically fresh salinity maximum and an uplifted, colder thermocline may have contributed to the underprediction of hurricane Sally's rapid intensification as it reached the Gulf Coast. HAFS output underestimated the depth of the 26°C isotherm, on average, by 9 decibars in the four 3-way comparisons shown here. The fresher surface salinity was not always modeled accurately, and the subsurface salinity maximum was sometimes attenuated.



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